BULLETIN

THE AMERICAN INTERPLANETARY SOCIETY

113 West 42nd Street, New York, N.Y.

David Lasser, President Clyde J. Fitch, Editor.

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CONTENTS

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1931-1932 Program Being Formulated

The 1931-1932 program of the Society will probably begin the third week of September.

An extension of the meetings held at the American Museum of Natural History will be made with the view to increasing the public interest in the rocket and interplanetary problems, and carrying on the Society's work of education.

Public meetings at which scientists will speak on the various phases of the rocket and its application, will be held; the research program of the Society on the rocket will be continued and extended, with reports by the members delivered at open meetings.

Plans for the beginning of rocket experimentation by the Society are maturing. The only obstacle at the time of writing is the obtaining of a suitable experimental field close to New York. When that had been obtained, it is expected that experiments on rocket combustion chambers will be made, and a body of data on the power developed by various chamber and different fuels will be built up. These data will be published in future issues of the Bulletin. It is the intention of the Society to lead its experimentation into a field where contributions of value can be made to the art of rocketry, and end in the sending of experimental rockets into the upper atmosphere.

With this work the Society hopes to stimulate rocket experimentation by responsible research men all over the country. It is believed that the speed with which the problems hindering the construction of rockets will be settled will be in proportion to the number of constructive minds working on it.

The extension of the field and scope of the Bulletin will probably be made early this fall. It is the intention of the Directors to make the Bulletin

a completely informative, readable and interesting source of data on the world-wide act··ities of rocket experimenters, and interplanetary societies. The Society will welcome from its members suggestions on how the Bulletin may most successfully fulfill its purpose.

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The German "Repulsor" Makes 1 ½ Kilometer Vertical Flight

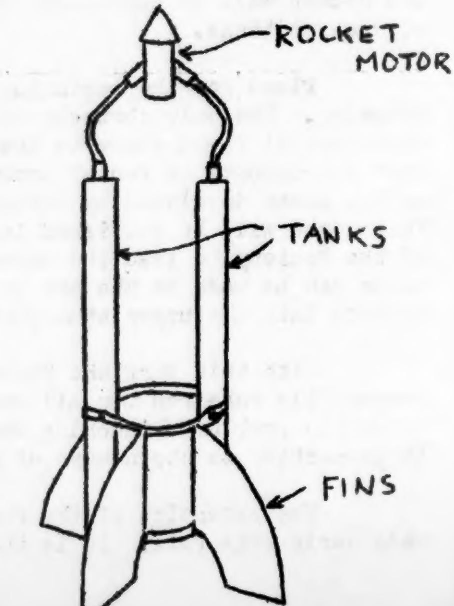
Vertical ascent of more than 1½ kilometers by a continuously burning liquid fuel rocket at the Raketenflugplatz in Berlin has been reported by Herr Willy Ley, vice-president of the Verein fur Raumschiffahrt. The new rocket, which Herr Ley describes as resembling a "flying proving stand" rather more than a conventional rocket, has been named the "Repulsor".

The Repulsor was constructed by Klaus Riedel, one of the Raketenflugplatz engineers; and is particularly valuable because it is both inexpensive and efficacious in making quick tests of a variety of rocket-motors (combustion chambers) which can be fitted to it.

The rocket consists of two thin round tanks about five feet long and two inches in diameter, placed about a foot apart and fastened so by two duralumin hoops near the lower end. On these hoops are four vanes to direct the device while in flight. The rocket-motor is placed at the top, supported by thin fuel-tubes which rise out of the top ends of the tanks. The entire rocket is thus extremely light and simple, and the weight is behind the motor, assuring greater stability.

In one of the rod-like tanks is placed a litre of liquid oxygen; in the other there is about a third of a litre of gasoline and sufficient nitrogen under pressure to force the fuel into the combustion chamber when the valve has been opened at the top. The oxygen, as in the Miraks, is forced into the motor by the pressure of its own gas.

In firing the Repulsor Herr Ley reports that the rocket must sit for six minutes (or when the sun is shining, four) to bring the pressure on the oxygen up to ten atmospheres. Then both tanks are opened and the rocket ignited. It starts upward with an acceleration of 32 feet per second per second which increases rapidly as the fuel is burned.



The Repulsor, like the Miraks, has demonstrated the efficiency of the rocket motors developed at the Raketenflugplatz, but shows that an enormous amount of work must still be done to solve the problem of stability and steering in flight. Like its predecessors, the liquid fuel rockets of Winkler and others, the Repulsor moves so swiftly that the eye can hardly follow it, and often in an extremely erratic course.

Herr Ley reports some amusing

experiences with the Repulsor, which has undergone repeated changes of structure as a result of accident and lessons learned from its flight.

In the first shot the rocket reached an altitude of only 45 meters. In the second it went nearly 440 meters. Encouraged by these results, the engineers were astounded by the action of the device upon the third trial. It went up only a few feet, turned suddenly and knocked against the wall of a nearby building, then spent its energy in a series of loops a few hundred feet in the air.

During these loops the cooling water (contained in a hood over the rocket motor) flowed out, and the rocket motor burst.

A similar experience, even more disastrous, brought an end to a subsequent experiment with this swift-moving apparatus. Riedel having repaired and rebuilt the rocket, he and one of his assistants filled the tanks, and two men lighted it. This time the Repulsor shot upward to an altitude of about 60 meters, then turned and rushed northward with a speed estimated at more than 360 kilometers an hour, almost out of the Raketenflugplatz.

At its greatest speed in this horizontal flight the rocket reached an estimated velocity of 470 kilometers a second. It burned for eight seconds only after the overturn, though the flight continued for more than four seconds on momentum. It was beginning to fall when, at a distance of more than 600 meters from the start it struck a tree and was smashed. The cooling water was found in the pot intact, though very hot, and the motor was undamaged.

As a result of lessons learned in this series of experiments the Repulsor was rebuilt, and so much improved that the vertical shot of $1\frac{1}{2}$ kilometers (about 1 mile) was obtained. It is expected that additional changes now being made will permit a vertical, controlled flight of more than twice this distance.

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Italian Rocket Plane Makes Successful Flights

Ettore Cattaneo, Italian engineer, recently completed a series of successful test flights with a rocket driven plane, at the Taliedo airport at Milan. In the last test, the craft remained aloft for 34 seconds and traveled a distance of one kilometer. The total weight of the craft is only about 280 kilograms (620 pounds).

For taking off, a special rocket lifts the plane off the ground with a force of 400 kilograms a second, for a duration of three or four seconds. When in the air, a number of rockets are exploded successively, giving a somewhat continuous driving force.

Signor Cattaneo is now busy constructing a new rocket plane which will weigh only 200 kilograms, and in which he plans to cross the English Channel.

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Is Space Empty?

This interesting question is thoroughly discussed by Henry Norris Russell, Ph. D., in an illuminating article in the September 1931 issue of the Scientific American.

It appears that various astronomers, while studying the spectrum of stars, noted that one line, the K line of calcium, behaved quite differently from the others. It remained bright and steady, while the others were hazy and shifted to and fro. This would indicate the presence of calcium gas between us and the star. Quoting, in part, from the article:

"Only rough estimates of the actual density of this gas can yet be made, but these are remarkable enough. The latest study by Unsold, Struve, and Elvey, indicates that within a few thousand light years of the sun there is on the average one absorbing calcium atom in every two or three cubic meters. Only a few small fractions of the atoms are in the singly ionized state which absorbs the observed lines. Existing calculations indicate that the proportion is something like one in a hundred thousand. This gives (closely enough) about one calcium atom per cubic inch.

It is very hard to realize what this infinitesimal density means. If there was nothing else but calcium, then it would require 60,000 cubic miles to contain one milligram of material, and more than a million cubic miles to weigh as much as a cubic inch of air! How many atoms of other sorts are present we can only guess. Probably enough to make a total density ten times as great. This estimate would make the total quantity of matter in interstellar space greater than that which is concentrated into the stars, and is likely to be too high rather than too low. In such a gas, according to Eddington, an atom would on the average move in a straight line for about seven years before being deflected by collision, and during this time would travel farther than the distance from the sun to Jupiter!

Strangely enough the gas, though in the depths of interstellar space, would be hot and not cold. The temperature of the gas depends on the average velocity with which its molecules or atoms move. In the present case this motion is caused mainly by the impacts of the free electrons. These are torn from their apparent atoms by the influence of ultra-violet light and set moving at a speed which depends on the quality and not the brightness of the light. Calculation shows that it will be high, and that when the impacts on the atoms have done their work their average rate of motion will correspond to a temperature about 10,000 degrees Centigrade. The gas is so excessively rarefied that a solid body immersed in it would not be perceptibly affected."

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THE NAVIGATION OF SPACE

(Abstract of Essay Submitted Dec. 1928 in the Rep-Hirsch Competition, By Noel Deisch).

Editor's Note: Mr. Deisch is a member of the American Interplanetary Society and has kindly given permission to the publication of his Essay in the Bulletin.

The prime object of astronautic research in its present development is clearly the investigation of means to secure propulsion in the medium of interplanetary space, and the provision of sources of energy adequate to make these means available for a journey to the moon or eventually to any point in the solar system. While it is conceivable that this excursion might be made by an unpiloted machine equipped with instruments arranged to bring back a scientific record, it is more consistent with the spirit of the project to think of it as made by a machine carrying a technical staff prepared for actual du visu

observation. Thus the transport of human beings becomes, if not the proximate, at least the ultimate concern of astronautics. Beyond propelling and fueling the ship, questions of its habitability must be met, and provision made to secure an approximate duplication within the confines of its hull of the conditions of environment that prevail on earth.

An Artificial Atmosphere.

Of the diverse ramifications of the general problem of environment, that of maintaining a continuous supply of fresh air in the living quarters of the etherodrome (space ship) is certainly of foremost importance. To hold the physical and chemical constitution of the body of air carried along with the ship substantially coincident with that of the earth's own atmosphere, implies, primarily, the measured addition of oxygen to offset what is absorbed during respiration, and the fixation of carbon dioxide simultaneously liberated. The various noisome organic compounds that will gradually collect must be destroyed, and the temperature, humidity, and pressure of the air must be maintained at that value which investigation has shown to be most conducive to health.

The total quantity of oxygen absorbed by a man during a full day depends upon his activity during that period, hence an accurate knowledge of the working hours of a sailor doing duty on an etherodrome is a prerequisite to forming a reliable estimate of his average respiratory activity. In the absence of any such information we must be content to assume that he would average eight hours of work (not severe exertion), eight hours of ease, and eight hours of sleep, in each twenty-four hours. These conditions being given, we have:

State of subject	Carbon dioxide liberated, grams per hour.	Oxygen absorbed, grams per hour.
Asleep	23	21
At ease	48	40
At work	145	125
Average	72	62

The total for 24 hours would be:

	Carbon dioxide liberated.	Oxygen absorbed
Grams	1,728	1,488
Litres, N.T.P.	898	1,041

This corresponds to a consumption of some 45 kilos of oxygen per man per month: the gas would therefore constitute no small item among the provisions of the vessel, and its efficient storage is hence a matter of considerable importance.

In point of reliability, the chemical processes have much to recommend them, more especially the hydrogen peroxide process, the potassium perchlorate, or the sodium peroxide process. All of these are thoroughly practicable, and make no call for heavy or complicated apparatus. The hydrogen peroxide method, in which the evolution of oxygen may be initiated and sustained through the simple presence of a suitable catalytic agent and without any application of heat, is particularly attractive; the oxygen is of the highest purity, and no solid by-product is left over from the reaction. In respect to weight-efficiency hydrogen peroxide solution stands as a very close rival to the element oxygen itself if the not unreasonable concession be made that the weight of water associated with the oxygen in hydrogen peroxide solution be subtracted from the total weight of such a solution. Granting the legitimacy of this correction we must assume the greater part of the expedition's water-supply to be stored as hydrogen peroxide solution and to become available for consumption only as the oxygen is abstracted from it.

Fixation of Carbon Dioxide.

Since the presence of as little as three per cent of carbon dioxide in the air causes distinct inconvenience, and since, according to our estimate, it would be added at the rate of some 1,728 grams per individual each 24 hours, it would not be long before a dangerous concentration of this gas would be reached in the confined quarters of the etherodrome.

The successive steps involved in applying a continuous process of removing carbon dioxide from the air might be roughly the following: calcium oxide, previously activated by hydration, would be exposed to the current of air from which the carbon dioxide were to be removed. When all the calcium hydroxide had been converted to the carbonate it would be transferred to a retort venting to space, calcined, and the calcium oxide produced by this operation would be used anew as a fixative.

The percentage relation of oxygen to nitrogen in the compartment is really of no great moment, for relatively large fluctuations in the percentage of oxygen present in the air could not cause the slightest injury to the crew.

Physiologists have shown that the amount of oxygen absorbed by the blood is nearly independent of the concentration of oxygen in the air breathed, provided enough be present to meet the needs of the organism.

Noxious Gases.

The fluctuations in the concentration of oxygen in the air of the vessel would be of much less weight in its bearing on health than the presence in this body of air of the various semi-poisonous vapors which are slowly generated as a natural accompaniment of life.

The efficiency of ozone as a deodorant is well known. Franklin who made experiments with all manner of uncommon odors showed that the saturated effluvia of onions, garlic, limburger cheese, and decayed fish, eggs, meat and oysters are completely discharged of odor by the action of the gas. The strong bactericidal powers of ozone are also of distinct interest in this connection.

Pressure, Temperature, and Relative Humidity.

A change of 20° C in temperature would bring a corresponding change of a

quarter kilogram in pressure, and an increase or decrease in percentage of oxygen by 5 per cent would cause less than a half kilogram difference of pressure, assuming the air to have been at the pressure of the atmosphere at sea-level when originally sealed in the etherodrome.

This last is an assumption, by the way, that may not be a very safe one, considering the great saving of weight in the sheeting of the vessel's hull that could be effected by the adoption of a lower pressure for the contained air. When out in space the vessel would in one sense constitute a huge air-receiver with walls proportioned to withstand an internal pressure of anywhere up to one atmosphere; these walls would, therefore, be fairly thick and proportionately heavy. Even a halving of their thickness by a lowering of the internal pressure would bring a respectable saving in the aggregate weight of the machine.

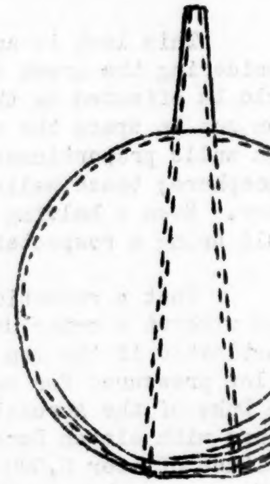
That a reduction of the barometric pressure to almost half of the normal, even without a coincident enrichment of the entrapped air by oxygen, might be practicable if the men were in good physical condition and had been accommodated to low pressures for some days prior to the departure is shown by the fact that the Duke of the Abruzzi in the course of his expedition into the Himalayas remained with eleven Europeans and fifteen coolies for about two months at an altitude of over 5,000 metres, corresponding to a pressure of not much over a half an atmosphere. All of the men worked regularly, and not one showed a single symptom of mountain sickness.

With an increase in the concentration of oxygen the pressure could of course be even farther lowered. As an illustration, it may be said that the U. S. Bureau of Mines has shown that laborers working with oxygen apparatus on the summit of Pikes Peak (elevation 4,300 metres) were able to do more work than they could perform without the apparatus at sea-level. Professor J. S. Haldane, whose theoretical and practical work in this field well qualifies him to give an opinion on this point says " At 36,000 feet (10,973 metres) a man breathing pure oxygen would be quite unaffected by the altitude. The barometric pressure is about 180 mm. In the alveolar air there would be a pressure of 47 mm of aqueous vapor and 40 mm of carbon dioxide. Hence (by difference) there would be 93 mm of oxygen pressure; and in the rarified air this would certainly suffice to saturate the arterial blood to the same extent as at sea-level."

It may be noted at this point that once the machine had scaled out to a position above the atmosphere the aggregate pressure stressing its hermetic shell, even when sub-normal pressures were used, would be enormous in a ship of any volume, and very careful attention would have to be given to the design of the hull and plating. Rigid requirements in the direction of economizing weight would probably dictate that the hull of the ship be essentially spherical in outline, since that is the geometrical figure best adapted to resist internal pressure with the minimum expenditure of material for a given cubic volume.

The high air resistance of a spherical body might be thought an objection in an etherodrome propelled by a reaction-motor. Leaving aside the possibility of streamlined shielding, it may be said that it is by no means certain that the high initial speeds that have been contemplated by some investigators of reaction-motored machines are unavoidable. Perhaps further development of the idea of this form of propulsion may include the use of an accessory carrier (be it balloon, balloon-helicopter, or induced-jet propeller) adapted to lift the machine through the denser strata of the atmosphere by action on the air itself, before the reaction-motor were called into play.

The result might be obtained by using a spherical vessel, containing a conical well constituting or containing the divergent nozzle, as shown in the illustration.



Sanitation

The problems incident to alimentation, both as regards provisioning the vessel and preparing the food for consumption, and those touching on sanitation, while they would undoubtedly be the subject of very close attention on the part of the designer of the etherodrome, present no outstanding fundamental difficulties. Refrigeration would permit the storage of all supplies necessary to the provision of a balanced diet. There is thus no apparent reason why the crew of an etherodrome should not dine from as well-assorted a table as the passengers of an up-to-date steamship, though, due to limitations of storage capacity, there would possibly be a certain stringency in the allotment of food and water to the members of the crew. Water would necessarily be consumed in considerable quantity not merely as a beverage, but as a detergent, and urgent reasons of economy would dictate that waste water used for the latter purpose be subjected to processes adapted to reclaim it for further use. After a preliminary precipitation and sedimentation of suspended matter, filtration, and if need be distillation, followed by treatment with a powerful oxidizing agent such as ozone to destroy surviving odors, the water should be entirely suitable for use as a cleansing agent.

Temperature Relations of a Body in Space.

Whatever the conditions of environment might be, it would be important that the living quarters of the vessel remain at a fairly constant temperature. With this fact in mind, it will be interesting to make an examination of the temperature relations that may subsist between an etherial craft and its environment, whether this environment be the medium of interplanetary space or the natural conditions of climate encountered after a landing has been effected on the surface of some distant body.

Anywhere in the vicinity of the solar system, - and that is the field wherein planetary discovery must be carried on, - only such radiation as comes from the sun need be considered, the total radiation that reaches us from the stars being so small that it may be disregarded. Fortunately, the temperature that a perfectly conducting theoretically "black" body, that is, one which absorbs and radiates heat freely, will attain if exposed to the radiation of the sun at any given point in space is subject to pretty accurate computation. The numerical results of such a computation by the English physicist J.H.Poynting is presented in the following table.

Black body situated at distance of	Temperature of black body, degrees C.
Mercury	210
Venus	85
Earth	27
Mars	-30
Neptune	- 210

Investigation has shown in general that bright and highly polished surfaces offer a high reluctance to heat transfers, we would expect the hull of the etherodrome to be externally silvered, or plated with nickel or chromium, so as to present a highly reflecting surface to the circumambient.

Gravitational Effects

As is well known, all the effects of gravity within an etherodrome would vanish immediately the driving or propelling force ceased to be exerted, irrespective of the gravitational environment of the machine, and it is quite possible that, as a result, serious physiological reactions doubly intensified, shows that the withdrawal of gravity for short periods need not have serious consequences.

Apart from embarrassments of a pathological nature, the personnel would, as has been elaborated on at length in fiction and essay, be seriously hampered in a merely physical way, due to an apparent change in the mechanical properties of objects.

Effect of High Accelerations

The general experience of engineers is that an acceleration of about 1.25 m/sec per sec is the highest that can be borne with entire comfort by most people in elevators and street-cars. However, we are here little concerned with comfort. On this subject Mr. Thos. E. Brown, consulting engineer of the Otis Elevator Company has the following to say: "Our experiments and experiences have been entirely with passengers traveling vertically in standing on their feet, where the effects of retardation have been along the axis of the body, the stress being principally on the ankles and spine. Under these conditions I and some of my associates have been subjected to retardations as high as 72 ft. sec. per sec. (21.94 m/sec per sec). Such retardation can be sustained without injury, and, in fact, without much discomfort. The stress on the ankles is quite noticeable.

"A man lying flat on the floor of an elevator could, without doubt, withstand at least double this retardation without serious inconvenience.

"In air-cushion practice it is customary to allow for retardations of five or even six times that of gravity, i.e., retardations up to 200 ft. per sec. per sec. (60.96 m/sec per sec) and it is considered that even this high retardation will not be injurious to life."

In fine, it seems certain that there is nothing inherent in the constitution of the cosmic spaces, and quite probably nothing existing in them by way of "contamination", that would in a positive way baffle an excursion out to the

worlds in the sky. We need only look to the striking example of our own planet which is nothing more than a great etherodrome carrying us forever as passenger on a tour through the wilderness of interstellar space, and all with so little incident that it seldom occurs to us that we are daily sweeping through hundred of thousands of kilometres of the astronomical void.

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"The Conquest of Space" Coming

To the Editor of the Bulletin:

Penguin Press wishes to announce to the members of the American Interpl tary Society the publication of "The Conquest of Space", by David Lasser, on September 28. This is the first non-fiction book dealing with the rocket and t interplanetary problem ever to be published in English. We feel the event to of sufficient importance to merit mention in your Bulletin.

Mr. Lasser has written one of the most thorough, and at the same time most vivid and exciting, accounts of the development of the rocket ever to appe in any language. In addition he has taken up in detail the problems of space navigation and pictured dramatically the experiences to be met with in a flight through space.

The introduction to "The Conquest of Space" was written by Dr. H. H. Sheldon, chairman of the Department of Physics, Washington Square College, New York University, who points out that Mr. Lasser, as president of the American Interplanetary Society, "is perhaps in a better position than anybody else in this country to speak with authority". Mr. Lasser, writes Dr. Sheldon, "has brought into the book the enthusiasm and vision that actuate scientists and inventors. The publishing of this book will undoubtedly prove to be a mileston in the progress of rocket study in this country."

Arrangements are being made by Penguin Press to make "The Conquest of Space" available to members of the American Interplanetary Society at publisher' discount. The retail price of the book in bookstores will be $3.

Penguin Press,
113 West 42nd Street,
New York, N. Y.

Meetings of the New York members of the American Interplanetary Society are held on the first and third Fridays of each month at the American Museum of Natural History, 77th Street and Central Park West. Persons interested in the aims of the Society are invited to attend and to write to the secretary, Nathan Schachner, 113 West 42nd Street, New York City, for information about the various classes of membership, including active, associate and special, which are open to men and women who possess the necessary qualifications.

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